



## Investigation of sella turcica morphometry in empty sella syndrome

Empty sella turcica morphometry

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### Abstract

**Aim:** Sella turcica is a saddle-like depression on the middle cranial fossa and on the upper surface of the sphenoid bone. It is a bone structure closely related to the pituitary gland and have anatomical and clinical importance. Empty sella syndrome is large or deformed radiologic image of sella turcica which has been partially or completely filled with cerebrospinal fluid. The purpose of our research is to investigate sella turcica morphometry in empty sella syndrome and to obtain a conclusion according to the literature on reasons and consequences of changing in sella turcica. **Material and Method:** In our study, computed tomography images of 33 adult participants with empty sella syndrome and 30 adult participants with normal findings as control group were used. Sella length, height, anterior-median-posterior heights, area, depth and anteroposterior diameter were measured in both groups. **Results:** In all variables, the values determined in the empty sella syndrome group were higher than the control group, but we found that sella depth and anterior-median-posterior heights were statistically significant. **Discussion:** It is known that sella turcica in empty sella syndrome expands. But we could not reach a morphometric study that shows this. We believe that the values detected in this study will be referred to physicians working on pituitary and sella surgeries.

### Keywords

Empty Sella Syndrome; Sella Turcica; CT; Morphometry

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## Introduction

Sella turcica (ST) is a saddle-like depression on the middle cranial fossa and on the upper surface of the sphenoid bone. ST is a bone structure closely related to the pituitary gland and have anatomical and clinical importance. ST is an anatomically complex structure that can be affected by neoplastic (e.g., microadenoma or macroadenoma), infectious, inflammatory, developmental (e.g., craniopharyngiomas), vascular pathologies and genetic factors in the sellar and parasellar regions. These pathologies often result in a significant changing shape [1-5]. Knowledge of the anatomy of the sellar region is important for neurologists and surgeons to make a diagnosis and treatments of the pathologies in this region. Particularly, in microsurgery of the sellar regional pathologies such as macroadenomas, all anatomical details regarding the possible variations of the sellar region are important to decide which surgical approach (transfrontal, transthemoidal, transsphenoidal, sublabial or endonasal) should be chosen [2].

Empty sella syndrome (ESS) is the radiological appearance of the sella turcica, which has been partially or completely filled with cerebrospinal fluid (CSF). The incidence of the ESS is 5% in the normal population [6-7]. It is more common in females [8-9]. ESS may arise from anatomic disorders such as a deficient sellar diaphragm; it may be accompanied by various disorders such as pseudotumor cerebri or often accompanied by intracranial pressure increase without any pathology [9,10].

Although the sella turcica morphometry in the different clinical situations was examined by researchers, we could not reach sufficient studies that examined these parameters in the empty sella syndrome in detail. We intended to investigate the turcicaST morphometry in the ESS to show the anatomical relationship between the ST morphometry and the ESS and to guide the clinicians working on this field regarding with the causes and clinical results of the changes in the ST dimensions.

## Material and Method

This study was approved by the Clinical Research Ethics Committee of the Afyon Kocatepe University. For the present study, radiological images of the outpatients from radiology department of the Afyon Kocatepe University were used. Ages of the participants were between 18-65. The study group consisted of 33 subjects who were diagnosed as ESS (27 female, 6 male) and the control group was 30 subjects who had no diagnosis and normal radiological findings (19 female, 11 male). Individuals with pituitary gland disease (tumor, cyst, hemorrhage, etc.), head trauma, any mass causing brain pressure (tumor, cyst, hemorrhage, etc.), brain vascular disease and pregnancy were excluded from the study.

CT examinations were performed on an 80-row detector CT (160 slice) scanner (Aquilion Prime, Toshiba Medical Systems, Nasu, Japan) with the following parameters: collimation, 80×2 mm; pitch factor, 0.625; rotation time, 0.75 sec; 120 kVp; 250 mAs, FOV: 220.3 mm and with a slice thickness of 0.5 mm. Morphometric measurements in the sagittal section nearest the mid-sagittal section were performed using the following 8 parameters (Figure 1).

Measured parameters:

**Sella length (SL):** The distance between the tuberculum sellae (TS) and the dorsum sellae (DS) (Figure 2).

**Sella width (SW):** The largest anteroposterior distance was measured in parallel to the Frankfurt Plan (FH) from the anterior and posterior points of ST (Figure 3).

**Sella anterior height (SAH):** Vertical distance was measured vertically to the FH from TS to the base of ST (Figure 2).

**Sella posterior height (SPH):** Vertical distance was measured vertically to the FH plan from the DS to the base of the ST (Figure 2).

**Sella median height (SMH):** Vertical distance was measured vertically to the FH plan from the midpoint of the line between TS and DS (Figure 2).

**ST area (STA):** The area of the portion of the line between TS and DS remaining in the sella.

**ST depth (DP):** The length of the line that drawn vertically to the ST length direction from the deepest point of the ST (Figure 3).

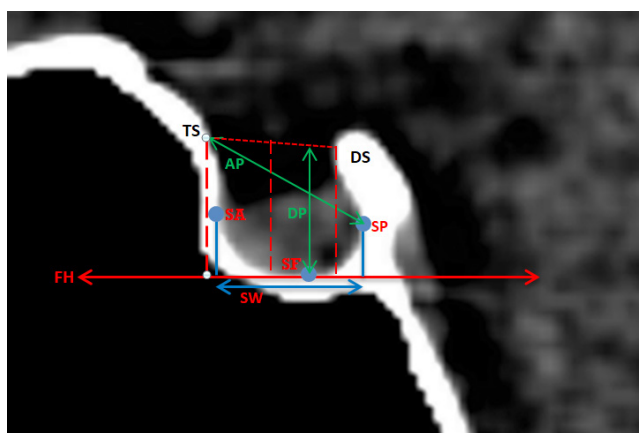


Figure 1. sella turcica measurements and reference points (TS: Tuberculum sellae , DS: Dorsum sellae , DP: Sella depth , AP: ST anteroposterior diameter , SW: Sella width , FH: Frankfurt horizontal plane , SF: Sella floor)

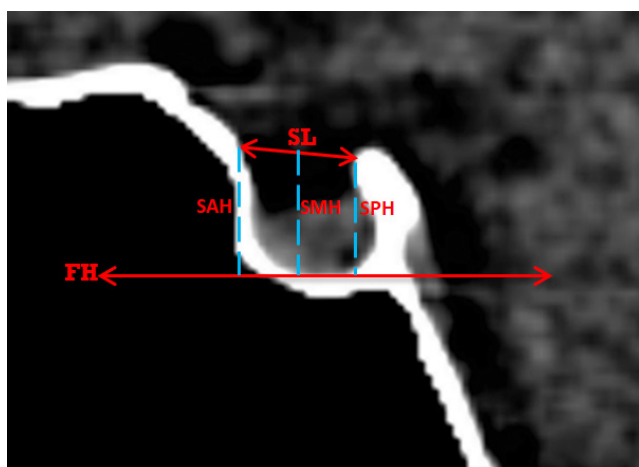


Figure 2. Sella turcica measurements (FH: Frankfurt horizontal plane , SL: Sella length , SAH: Sella anterior height , SMH: Sella median height , SPH: Sella posterior height)

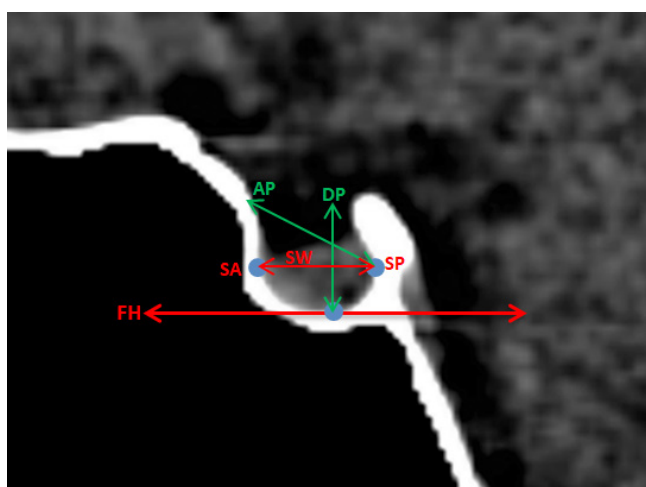


Figure 3.  
Sella turcica measurements (FH: Frankfurt horizontal plane  
, AP: ST anteroposterior diameter  
, SW: Sella width  
, SF: Sella floor  
, DP: Sella depth  
, SA: Sella anterior  
, SP: Sella posterior)

**ST anteroposterior diameter (AP):** The distance was measured from the TS to the most posterior point on the inside of the fossa hypophysis (Figure 3).

Data in the study were evaluated using IBM SPSS (Statistical Package for the Social Sciences, version 20.0; IBM, Chicago, IL, USA) software. Descriptive statistics were presented as the mean and standard deviation ( $\pm$ ). The independent samples t-test was used for paired groups when comparing parametric values, Mann-Whitney U test was used when comparing two groups for non-parametric data. Correlation analyses between the groups were performed using Pearson's correlation test. Statistical significance in the inter-group comparisons was defined as a value of the  $p < 0.05$ .

## Results

The mean age of the control group was  $42.1 \pm 11.17$ , and the mean age of the study group was  $52.1 \pm 17.99$ . Nineteen (63%) of the 30 patients in the control group were female, and 11 (37%) were male; 27 (82%) of the 33 patients in the ESS group were female, and 6 (18%) were male (Table 1).

The mean ST anterior height was  $8.18 \pm 1.49$  mm in the control group and  $9.76 \pm 2.87$  mm in the study group ( $p = 0.015$ ). The mean ST median height in the control group was  $7.74 \pm 1.12$  mm and  $10.37 \pm 2.62$  mm in the study group ( $p = 0.001$ ). The mean

Table 1. Measurements in control and ESS groups.\*  $p \leq 0.05$

Measurements	Control (n=30)	ESS (n=33)	p
Age	$42.1 \pm 11.17$	$52.1 \pm 17.99$	0.200
ST length (mm)	$8.96 \pm 2.13$	$11.24 \pm 2.63$	0.200
ST width (mm)	$9.89 \pm 1.68$	$11.13 \pm 2.70$	0.200
ST anterior height (mm)	$8.18 \pm 1.49$	$9.76 \pm 2.87$	0.015*
ST median height (mm)	$7.74 \pm 1.12$	$10.37 \pm 2.62$	0.001*
ST posterior height (mm)	$7.40 \pm 1.19$	$11.2 \pm 3.19$	0.001*
ST area (mm <sup>2</sup> )	$69.55 \pm 17.26$	$96.1 \pm 19.89$	0.200
ST depth (mm)	$7.90 \pm 1.33$	$10.54 \pm 2.55$	0.001*
ST anteroposterior diameter (mm)	$11.42 \pm 2.17$	$12.1 \pm 2.7$	0.200

ST: Sella Turcica

posterior height in the control group was  $7.40 \pm 1.19$  mm and  $11.2 \pm 3.19$  mm in the ESS patients ( $p = 0.000$ ). The mean ST depth in the control group was  $7.90 \pm 1.33$  mm and  $10.54 \pm 2.55$  mm in the ESS patients ( $p = 0.001$ ) (Table 1).

In all parameters, the results of the ESS group were higher than the control group. Also, the differences between the ST anterior-median-posterior heights and ST depths were statistically significant between control group and study group.

## Discussion

ST is an important structure of middle cranial fossa, and its size is important for the recognition of certain pathologies [11-12]. Meschan pointed out that measurements of sella turcica should be made to determine the intracranial pressure as well as intrasellar lesion enlargement [13]. Previous studies indicated the different clinical conditions such as pseudotumor cerebri [14], Sheehan's syndrome [15] and intracranial hypertension [16] might significantly alter the ST morphometry.

According to the previous studies in the literature, there are changes in sella turcica of the patients with empty sella syndrome such as subarachnoid herniation and enlargement due to factors such as increased cerebrospinal fluid (CSF) pressure [8,14,17,18]. Apart from ST expansion in ESS, there is no study related to a detailed analysis of sella turcica in ESS in the literature.

As a result, all parameters of ST were found to be higher in the ESS group than in the control group, but ST anterior-median-posterior heights and ST depth measurements were statistically significant between the control group and the study group. When we compare the values obtained from the control group with other studies performed on the normal population, we found that the similar results in the Iraqi population [19]. This similarity shows that ST morphometry may be influenced by race, geography and climatic conditions.

Guitelman et al. reported abnormally and expanded ST in their study performed 175 patients with primary ESS [8]. Kyung et al. also found that ST in the patients with secondary ESS associated with pseudotumor cerebri was expanded according to the control group and this result in ESS appearance [14]. Data in our study supports the knowledge that ST expands in ESS, which is included in the literature [2,14,17,18,20]. In contrast, Yoon et al. reported that the ST in a case with chronic intracranial hypotension is shrinking [21]. In a study conducted by Sherif et al. on patients with 57 Sheehan's syndromes, ST volume was significantly lower in patients group than in the control group [15].

The previous studies in the literature claimed that the pressure increase in the ST (intracranial hypertension etc.) enlarges the ST. Whereas it decreases in the cases where the intracranial pressure falls, or the ST content decreases. In addition, ST morphometry can be varied in different clinical situations.

## Conclusion

Especially in the transsphenoidal and transoral approaches used for pituitary surgery, knowing the sellar and parasellar anatomy is necessary. We believe that the morphometric measurements we detected in ESS will lead to physicians working on pituitary and ST surgery.

As a result of our study, we observed that any local or systemic clinical problem affecting the sellar and parasellar region can change the ST morphometry. A tissue or organ, whether large or small, may be variational or pathological, as well as physical interaction with neighboring tissues or organs.

#### Scientific Responsibility Statement

*The authors declare that they are responsible for the article's scientific content including study design, data collection, analysis and interpretation, writing, some of the main line, or all of the preparation and scientific review of the contents and approval of the final version of the article.*

#### Animal and human rights statement

*All procedures performed in this study were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. No animal or human studies were carried out by the authors for this article.*

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#### Conflict of interest

*None of the authors received any type of financial support that could be considered potential conflict of interest regarding the manuscript or its submission.*

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